

1 WE CLAIM:

2 1. A method of obtaining data for a geographic database comprising:
3 providing data indicating a plurality of locations along roads, including data
4 indicating altitudes at the plurality of locations;
5 computing road grade values for a plurality of subsections of the road, each of the
6 subsections being a portion of the road between two of the locations;
7 identifying a plurality of temporary change points, each of the temporary change
8 points joins two adjacent subsections having road grade values that differ by a value
9 greater than a predetermined amount;
10 computing a road grade value for each part of the road between adjacent
11 temporary change points;
12 grouping consecutive parts of the road having road grade values that fall within a
13 predetermined range into at least one constant road grade section; and
14 storing data that define the constant road grade section in the geographic database.

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16 2. The method of Claim 1 further comprising filtering the data to remove
17 closely spaced locations.

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19 3. The method of Claim 1 further comprising deriving a smooth altitude
20 profile along the road.

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22 4. The method of Claim 3 wherein the smooth altitude profile is derived
23 using a least squares polynomial.

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25 5. The method of Claim 1 wherein the temporary change points include a
26 plurality of zero-crossing points, wherein each of the zero-crossing points joins two
27 adjacent subsections having road grade values that change from positive to negative.

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1 6. The method of Claim 5 wherein the temporary change points include a
2 plurality of pseudo zero-crossing points, wherein each of the pseudo zero-crossing points
3 joins two adjacent subsections between zero-crossing points having road grade values
4 that differ by a value greater than a predetermined amount.

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6 7. The method of Claim 6 wherein said pseudo zero-crossing points are
7 identified by performing a rotational transformation of an altitude profile between two
8 adjacent zero-crossing points.

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10 8. The method of Claim 1 further comprising:
11 determining whether the constant road grade section has a corresponding road
12 distance less than a minimum distance; and
13 if the constant road grade section has the corresponding road distance less than
14 said minimum distance, merging the constant road grade section with an adjacent
15 constant road grade section.

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17 9. A method of obtaining data for a geographic database comprising:
18 providing data indicating a plurality of locations along roads, including data
19 indicating altitudes at the plurality of locations;
20 computing a road grade value for each of a plurality of subsections of said road,
21 each of the subsections defined by two of the locations;
22 if the road grade values of adjacent subsections fall within a predetermined range,
23 grouping the subsections into at least one constant road grade section; and
24 storing data that define the constant road grade section in the geographic database.

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26 10. The method of Claim 9 further comprising deriving a smooth altitude
27 profile along the road.

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29 11. The method of Claim 9 further comprising identifying a grade change
30 point corresponding to a position connecting adjacent constant road grade sections.

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1 12. The method of Claim 9 further comprising:
2 determining whether the constant road grade section has a corresponding road
3 distance less than a minimum distance; and
4 if the constant road grade section has the corresponding road distance less than
5 said minimum distance, merging the constant road grade section with an adjacent
6 constant road grade section.

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8 13. The method of Claim 9 further comprising computing a road grade value
9 for the constant road grade section.

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11 14. The method of Claim 13 further comprising:
12 if the road grade value of the constant road grade section is greater than a
13 maximum road grade value, identifying the constant road grade section for human
14 inspection.

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16 15. The method of Claim 13 further comprising:
17 if the road grade value of the constant road grade section is greater than a
18 maximum road grade value, merging the constant road grade section with an adjacent
19 constant road grade section.

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21 16. The method of Claim 9 further comprising using the data indicating
22 altitudes as an input to a Hough Line Transform to determine straight line segments
23 corresponding with the constant road grade sections.

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1 17. A method of representing road geometry for a geographic database
2 comprising:
3 providing data indicating a plurality of locations along roads, including data
4 indicating altitudes at the plurality of locations;
5 computing a road grade value for each of a plurality of subsections of the road,
6 each of said subsections defined by a pair of locations;
7 if said road grade values of adjacent subsections differ by a value greater than a
8 predetermined amount, identifying said location between said adjacent subsections as a
9 grade change point; and
10 storing data that define said grade change point in the geographic database.

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12 18. The method of Claim 17 identifying a road grade value for each constant
13 road grade section between adjacent grade change points.

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15 19. The method of Claim 17 further comprising:
16 determining whether a road distance between adjacent grade change points is less
17 than a minimum distance; and
18 if the road distance between adjacent grade change points is less than said
19 minimum distance, eliminating one of said adjacent grade change points.

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21 20. A method of representing road geometry for a geographic database
22 comprising:
23 providing data indicating a plurality of locations along roads, including data
24 indicating altitudes at said plurality of locations;
25 using the data indicating altitudes and horizontal distance along the road as inputs
26 to a Hough Line Transform to determine a plurality of straight line segments
27 corresponding to a plurality of constant road grade sections along the road; and
28 storing data that define said constant road grade sections in the geographic
29 database.

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1 21. The method of Claim 20 further comprising identifying a grade change
2 point corresponding to a location of an intersection of adjacent straight-line segments
3 determined by the Hough Line Transform.

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5 22. The method of Claim 20 further comprising identifying a road grade value
6 of one of said constant road grade sections as a slope of said corresponding straight-line
7 segment.

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